

Certified Reference Material

Certificate of Analysis

Product ID: IARM-FEF1-21

ISO
17034:2016

ISO/IEC
17025:2017

ISO
9001:2015

Product Description: Alloy Steel, A182 Grade F1 (C1/2Mo)/K12822

Revision No.: 000
Revision Date: 11/15/2022

Description and Intended Use: This **Certified Reference Material** is covered under the scope of accreditation to **ISO 17034** by LGC Standards - Manchester, NH. As an ISO 17034 certified reference material, appropriate use of this material will fulfill the certified reference material and traceability requirements for use in **ISO 17025** accredited laboratories. This CRM may come in the form of a solid disk, or chips. The intended use of this CRM may include, but is not limited to, the calibration of instruments and the validation of analytical methods.

Certified Values listed in wt.% with associated uncertainties

Al	0.028	± 0.001	Cu	0.0125	± 0.0007	O	0.0024	± 0.0005	Ti	0.0021	± 0.0004
As	0.0021	± 0.0004	Mn	0.811	± 0.009	P	0.012	± 0.001	V	0.0191	± 0.0009
B	0.0010	± 0.0003	Mo	0.48	± 0.01	Pb	0.0009	± 0.0003	W	0.0022	± 0.0008
C	0.235	± 0.006	N	0.0070	± 0.0006	S	0.0060	± 0.0006	Zr	0.0014	± 0.0003
Co	0.0095	± 0.0004	Nb	0.0087	± 0.0007	Si	0.278	± 0.007			
Cr	0.188	± 0.003	Ni	0.058	± 0.001	Sn	0.0016	± 0.0005			

Indicative Values listed in ppm

Bi (11) Ca (11) Fe (Bal) Sb (12)

Homogeneity and Uncertainty: "Uncertainty" values, as reported adjacent to certified concentration values, are based on a 95% Confidence Interval. These estimated uncertainties include the combined effects of method imprecision, material inhomogeneity, and any bias between methods. Homogeneity data from experimental XRF results are reflected in both the overall statistics and certified data. Homogeneity samples are selected by a systematic sampling procedure. The number of samples may be determined by equation 1, where N_{prod} is the number of units produced and N_{min} is the number of samples used for homogeneity testing. These samples are arranged in a simple randomized design such that each sample is analyzed multiple times by XRF. Homogeneity may also be determined within sample using an applied version of ASTM E826. A single factor ANOVA is used to calculate uncertainty due to inhomogeneity (U_{hom}). Uncertainty of the material is calculated by equation 2, where $H = U_{hom}$, S = Standard deviation, t = t-value at 95% CI, and n = number of observations.

$$1. N_{MIN} = \max(10, \sqrt[3]{N_{PROD}})$$

$$2. U_{CRM} = \frac{\sqrt{H^2 + S^2}}{\sqrt{n}} * t$$

Certification Laboratories: Much of the analytical work performed to assess this material has been carried out by laboratories with proven competence, as indicated by their accreditation to ISO 17025. It is an implicit requirement for this accreditation that analytical work should be performed with due traceability, via an unbroken chain of comparisons, each with stated uncertainty, to primary standards such as the mole, or to nationally- or internationally-recognized reference materials. Of the individual results herein, some have traceability (to the mole) via primary analytical methods. Some are traceable to substances of known stoichiometry. Most have traceability via commercial solutions. Furthermore, some results have additional traceability to NIST standards, as part of the analytical calibration or process control.

- AnchorCert Analytical - Birmingham, England
- Applied Technical Services - Marietta, GA
- Cleveland Cliffs - West Chester, OH
- Connecticut Metallurgical, Inc. - East Hartford, CT
- Dirats Laboratories - Westfield, MA
- Eurofins EAG Laboratories - Liverpool, NY
- IMR Test Labs - Louisville, KY
- LGC Standards - Manchester, NH
- Lithea S.R.O. - Brno, Czech Republic
- Luvac Inc - Boylston, MA
- New Hampshire Materials Laboratory - Somersworth, NH
- NSL Analytical Services - Cleveland, OH
- Scrooby's Laboratory Service Pty Ltd - Benoni, South Africa
- SGS MSI - Melrose Park, IL
- TCR Engineering Services Pvt. Ltd - Navi Mumbai, India

Instructions for Use: The test surface is on the opposite side of the labeled surface, which includes the material identification. The entire thickness of the unit is certified. However, the user is cautioned not to measure disks less than 2 mm thick when using X-ray fluorescence spectrometry. Each packaged disk has been prepared by finishing the test surface using a lathe. The user must determine the correct surface preparation procedure for each analytical technique. The user is cautioned to use care when either resurfacing the disk or performing additional polishing, as these processes may contaminate the surface. The minimum sample size for chips should be individually evaluated based on the analytical technique used; this would typically be greater than 0.1 grams. The material should be stored in a cool, dry location when not in use.

Chips are not recommended for gas analysis.

Period of Validity: The certification of this material is valid indefinitely, within the uncertainty specified, provided the material is handled and stored in accordance with the instructions stated on this certificate. The certification is nullified if the material is damaged, contaminated, otherwise modified, or used in a manner for which it was not intended.

Chuck Goudreau

Chuck Goudreau, Certifying Officer

November 15, 2022
Certification Date



ISO 17034 Accredited: Reference Materials
Producer, Certificate # 2848.02
ISO/IEC 17025 Accredited: Chemical
Testing, Certificate # 2848.01



Conditions of Sale and Supply: All CRMs & RMs sold are subject to applicable LGC Standard Terms and Conditions of Sale.

The following data represents all pertinent information reported as it applies to the chemical characterization of this material.

	Al	As	B	Bi	C	Ca	Co	Cr	Cu	Mn	Mo	N	Nb
1	0.0250	0.0012	0.0002	0.0003	0.2170	0.0002	0.0079	0.1770	0.0096	0.7660	0.4460	0.0058	0.0060
2	0.0256	0.0015	0.0003	0.0005	0.2200	0.0002	0.0081	0.1788	0.0100	0.7760	0.4590	0.0060	0.0074
3	0.0258	0.0016	0.0004	0.0010	0.2210	0.0010	0.0086	0.1800	0.0100	0.7820	0.4600	0.0064	0.0080
4	0.0260	0.0016	0.0008	0.0014	0.2225	0.0010	0.0090	0.1801	0.0110	0.7870	0.4620	0.0069	0.0080
5	0.0260	0.0018	0.0008	0.0014	0.2310	0.0010	0.0090	0.1810	0.0110	0.7910	0.4650	0.0070	0.0080
6	0.0262	0.0018	0.0009	0.0020	0.2310	0.0010	0.0090	0.1820	0.0112	0.8003	0.4680	0.0071	0.0080
7	0.0268	0.0019	0.0010	<0.0005	0.2330	0.0030	0.0090	0.1830	0.0120	0.8030	0.4680	0.0072	0.0080
8	0.0271	0.0022	0.0010	<0.0007	0.2400	<0.0005	0.0090	0.1850	0.0120	0.8040	0.4690	0.0078	0.0082
9	0.0275	0.0023	0.0010	<0.0010	0.2407	<0.0010	0.0091	0.1850	0.0126	0.8090	0.4700	0.0080	0.0086
10	0.0277	0.0027	0.0010	<0.002	0.2420	<0.002	0.0094	0.1850	0.0127	0.8100	0.4775	0.0080	0.0091
11	0.0285	0.0028	0.0012	<0.002	0.2420	<0.002	0.0094	0.1855	0.0128	0.8101	0.4780		0.0092
12	0.0286	0.0030	0.0015	<0.002	0.2425	<0.002	0.0096	0.1860	0.0130	0.8190	0.4781		0.0100
13	0.0291	0.0030	0.0015	<0.002	0.2460	<0.0050	0.0097	0.1860	0.0130	0.8200	0.4820		0.0100
14	0.0295	<0.0001	0.0015	<0.01	0.2480		0.0098	0.1900	0.0130	0.8230	0.4870		0.0101
15	0.0300	<0.0006	0.0016		0.2490		0.0098	0.1900	0.0130	0.8230	0.4870		0.0102
16	0.0300	<0.002	<0.0005				0.0100	0.1920	0.0130	0.8236	0.4915		0.0104
17	0.0302	<0.002	<0.01				0.0100	0.1930	0.0132	0.8240	0.4920		<0.01
18	0.0310	<0.002	<0.01				0.0104	0.1943	0.0133	0.8260	0.5012		
19	0.0320	<0.0050					0.0105	0.1973	0.0140	0.8277	0.5030		
20	0.0330	<0.01					0.0120	0.1980	0.0150	0.8312	0.5090		
21		<0.01					<0.01	0.2000	0.0153	0.8400	0.5130		
22							<0.01	0.2000	0.0154	0.8400	0.5290		
23								0.2010			0.5427		
24													
Mean	0.0283	0.0021	0.0010	0.0011	0.2350	0.0011	0.0095	0.1883	0.0125	0.8107	0.4843	0.0070	0.0087
STDV	0.0023	0.0006	0.0005	0.0006	0.0108	0.0009	0.0009	0.0074	0.0016	0.0203	0.0236	0.0008	0.0012
Certified	0.028	0.0021	0.0010	(0.0011)	0.235	(0.0011)	0.0095	0.188	0.0125	0.811	0.48	0.0070	0.0087
U _{CRM}	0.001	0.0004	0.0003		0.006		0.0004	0.003	0.0007	0.009	0.01	0.0006	0.0007
Methods	I,IM,O,X	I,G,IM,O,A,X	I,G,IM,O	I,IM,O,X	C,G,O,I	I,G,IM,O,X	I,G,IM,O,X	I,G,IM,O,X	I,IM,O,X	I,G,O,X	I,O,X	O,F,I	I,G,IM,O,X

	Ni	O	P	Pb	S	Sb	Si	Sn	Ti	V	W	Zr
1	0.0530	0.0019	0.0077	0.0003	0.0045	0.0002	0.2428	0.0005	0.0010	0.0160	0.0003	0.0007
2	0.0530	0.0020	0.0089	0.0003	0.0048	0.0003	0.2520	0.0005	0.0010	0.0167	0.0003	0.0010
3	0.0540	0.0021	0.0090	0.0004	0.0049	0.0004	0.2600	0.0009	0.0012	0.0169	0.0005	0.0010
4	0.0548	0.0025	0.0100	0.0008	0.0050	0.0006	0.2600	0.0010	0.0016	0.0170	0.0007	0.0011
5	0.0550	0.0026	0.0105	0.0008	0.0050	0.0010	0.2610	0.0010	0.0017	0.0174	0.0014	0.0011
6	0.0560	0.0031	0.0107	0.0009	0.0050	0.0012	0.2666	0.0013	0.0019	0.0180	0.0020	0.0012
7	0.0560		0.0110	0.0010	0.0051	0.0014	0.2710	0.0014	0.0020	0.0180	0.0024	0.0012
8	0.0570		0.0110	0.0010	0.0053	0.0020	0.2740	0.0016	0.0020	0.0180	0.0030	0.0013
9	0.0578		0.0120	0.0012	0.0061	0.0020	0.2775	0.0018	0.0020	0.0185	0.0030	0.0015
10	0.0579		0.0128	0.0014	0.0065	0.0030	0.2780	0.0021	0.0020	0.0189	0.0032	0.0017
11	0.0583		0.0130	0.0020	0.0069	<0.0010	0.2800	0.0022	0.0020	0.0189	0.0035	0.0020
12	0.0587		0.0130	<0.001	0.0070	<0.002	0.2800	0.0023	0.0021	0.0189	0.0039	0.0020
13	0.0590		0.0130	<0.0010	0.0070	<0.002	0.2830	0.0028	0.0028	0.0190	0.0040	0.0020
14	0.0590		0.0139	<0.002	0.0072	<0.002	0.2850	0.0030	0.0034	0.0190	<0.0010	<0.00005
15	0.0591		0.0140	<0.002	0.0072	<0.002	0.2864	<0.001	0.0034	0.0191	<0.005	<0.0010
16	0.0598		0.0140	<0.002	0.0078		0.2880	<0.0010	0.0034	0.0200	<0.01	<0.01
17	0.0598		0.0146	<0.01			0.2890	<0.002	<0.002	0.0201		<0.01
18	0.0598		0.0150	<0.01			0.2900	<0.002	<0.002	0.0210		
19	0.0600		0.0160				0.2910	<0.002	<0.002	0.0210		
20	0.0620		0.0160				0.2960	<0.01	<0.01	0.0220		
21	0.0620						0.2960	<0.01		0.0220		
22	0.0620						0.3020			0.0240		
23	0.0632											
24	0.0651											
Mean	0.0584	0.0024	0.0123	0.0009	0.0060	0.0012	0.2777	0.0016	0.0021	0.0191	0.0022	0.0014
STDV	0.0032	0.0005	0.0024	0.0005	0.0011	0.0009	0.0154	0.0008	0.0008	0.0020	0.0014	0.0004
Certified	0.058	0.0024	0.012	0.0009	0.0060	(0.0012)	0.278	0.0016	0.0021	0.0191	0.0022	0.0014
U _{CRM}	0.001	0.0005	0.001	0.0003	0.0006		0.007	0.0005	0.0004	0.0009	0.0008	0.0003
Methods	I,G,IM,O,X	F	I,G,IM,O,X	I,G,IM,O,A,X	C,O,I,X	IM,I,O,A,X	I,G,IM,O,X	I,G,IM,O,A,X	I,IM,O,X	I,G,IM,O,X	I,G,IM,O	I,G,IM,O,X

Legend: W = Classical, C = Combustion, F = Fusion, A = AA or GFAA, I = ICP or DCP, IM=ICP-MS, D = DC Arc, O = AES, X = XRF, G = GDAES or GDMS, H = Hollow Cathode AES